Laboratory centrifuge

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A **laboratory centrifuge** is a piece of laboratory equipment, driven by a motor, which spins liquid samples at high speed. There are two main sizes for laboratory centrifuges. The larger ones are known simply as centrifuges; samples are contained in **centrifuge tubes** or **centrifuge tips**. The smaller centrifuges are known as **microcentrifuges** or **microfuges**, and **microcentrifuge tubes** or **microfuge tubes** are used with them.

Like all other centrifuges, laboratory centrifuges work by the sedimentation principle, where the centripetal acceleration is used to separate substances of greater and lesser density.

Laboratory centrifuge

A tabletop laboratory centrifuge

Uses	Separation
Related items	Gas centrifuge Ultracentrifuge

Contents

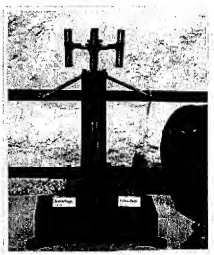
- 1 Operation
- 2 Types
- 3 Design
- 4 Centrifuge tubes
  - 4.1 Microcentrifuge tubes
- 5 Safety
- 6 Theory
- 7 See also
- 8 References
- 9 External links

Operation

Increasing the effective gravitational force will more rapidly and completely cause the precipitate ("pellet") to gather on the bottom of the tube. The remaining solution is called the "supernate" or "supernatant".

The supernatant liquid is then either quickly decanted from the tube without disturbing the precipitate, or withdrawn with a Pasteur pipette. The rate of centrifugation is specified by the acceleration applied to the sample, typically measured in revolutions per minute (RPM) or *g*. The particles' settling velocity in centrifugation is a function of their size and shape, centrifugal acceleration, the volume fraction of solids present, the density difference between the particle and the liquid, and the viscosity.

The use of a centrifuge is known as centrifugation.



A 19th century hand cranked laboratory centrifuge.

Types

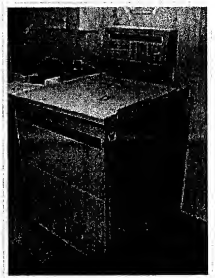
There are various types of centrifugation:

Exhibit A
Application No. 10/538,498

- Differential centrifugation
- Isopycnic centrifugation
- Sucrose gradient centrifugation

Design

Laboratory centrifuges are used in chemistry, biology, and biochemistry for isolating and separating solids from liquids in a suspension. The solids can be insoluble compounds, biomolecules, cell organelles, or whole cells. They vary widely in speed and capacity. They usually comprise a rotor containing two, four, six, or many more numbered wells within which centrifuge tubes may be placed.



A large laboratory centrifuge.

When a suspension in a centrifuge tube is centrifuged, the solids settle at the bottom of the centrifuge tube; having a tapered wall helps to concentrate the solids, making it easier to decant the supernatant solution, leaving the solids.

The rotor is covered by a plastic cover. The cover is usually interlocked to prevent the motor from turning the rotor when it is open, and from allowing the cover to be opened before the rotor stops for several minutes. The cover protects the user from being injured by touching a rapidly spinning rotor. It also protects the user from fragments in case the rotor fails catastrophically.

The rotor must be balanced by placing samples or blanks of equal mass opposite each other. Since most of the mass is derived from the solvent, it is usually sufficient to place blanks or other samples of equal volume. As a safety feature, some centrifuges may stop turning when wobbling is detected.

Centrifuge tubes

Centrifuge tubes or **centrifuge tips** are tapered tubes of various sizes made of glass or plastic. They may vary in capacity from tens of millilitres, to much smaller capacities used in microcentrifuges used extensively in molecular biology laboratories. The most commonly encountered tubes are of about the size and shape of a normal test tube (~ 10 cm long). Microcentrifuges typically accommodate microcentrifuge tubes with capacities from 250 µl to 2.0 ml. These are exclusively made of plastic.

Glass centrifuge tubes can be used with most solvents, but tend to be more expensive. They can be cleaned like other laboratory glassware, and can be sterilized by autoclaving. Plastic centrifuge tubes, especially microcentrifuge tubes tend to be less expensive. Water is preferred when plastic centrifuge tubes are used. They are more difficult to clean thoroughly, and are usually inexpensive enough to be considered disposable.

Microcentrifuge tubes

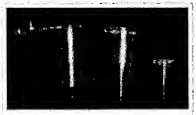
Microcentrifuge tubes or **microfuge tubes** are small, cylindrical plastic containers with conical bottoms, typically with an integral snap cap. They are used in molecular biology and biochemistry to store and centrifuge small amounts of liquid. As they are inexpensive and considered disposable, they are used by many chemists and biologists as convenient sample vials in lieu of glass vials; this is particularly useful when there is only a small amount of liquid in the tube or when small amounts of other liquids are being added, because microcentrifugation can be used to collect the

drops together at the bottom of the tube after pipetting or mixing.

Microcentrifuge tube with Coomassie Blue solution

Made of polypropylene,[1] they can be used in very low temperature (-80 °C to liquid nitrogen temperatures) or with organic solvents such as chloroform. They come in many different sizes, generally ranging from 250 µL to 2.0 mL. The most common size is 1.5 mL. Disinfection is possible (1 atm, 120 °C, 20 minutes), but due to their low cost and the difficulty in cleaning the plastic surface, they are usually discarded after each use.

Eppendorf tube has become a genericized trademark for *microfuge tubes* or *microcentrifuge tubes*. Eppendorf is a major manufacturer of this item, but is not the only one.



Three microcentrifuge tubes: 2 mL, 1.5 mL and 200 µL (for PCR).

Four screw-top microcentrifuge tubes.

Safety

The load in a laboratory centrifuge must be carefully balanced. Small differences in mass of the load can result in a large force imbalance when the rotor is at high speed. This force imbalance strains the spindle and may result in damage to centrifuge or personal injury.

Centrifuge rotors should never be touched while moving, because a spinning rotor can cause serious injury. Modern centrifuges generally have features that prevent accidental contact with a moving rotor.

Because of the kinetic energy stored in the rotor head during high speed rotation, those who have experienced the loss of a rotor inside of an ultracentrifuge compare the experience to having a bomb explode nearby.

Theory

Protocols for centrifugation typically specify the amount of acceleration to be applied to the sample, rather than specifying a rotational speed such as revolutions per minute. The acceleration is often quoted in multiples of g, the acceleration due to gravity at the Earth's surface. This distinction is important because two rotors with different diameters running at the same rotational speed will subject samples to different accelerations.

The acceleration can be calculated as the product of the radius and the square of the angular velocity.

Relative centrifugal force is the measurement of the force applied to a sample within a centrifuge. This can be calculated from the speed (RPM) and the rotational radius (cm) using the following calculation.

$$g = \mathrm{RCF} = 0.00001118 \times r \times N^2$$

where:

g = Relative centrifuge force
r = rotational radius (centimetre, cm)
N = rotating speed (revolutions per minute, r/min)

To avoid having to perform a mathematical calculation every time, one can find nomograms for converting RCF to rpm for a rotor of a given radius. A ruler or other straight edge lined up with the radius on one scale, and the desired RCF on another scale, will point at the correct rpm on the third scale. Example (http://aquaticpath.umd.edu/nomogram.html)

See also

- Centrifuge
- Centrifugation
- Gas centrifuge
- Separation
- Ultracentrifuge

References

1. ^ "Chemical Stability of Disposables (http://www.eppendorfna.com/utilities/enewsletter.asp?ENLUID=e200606&REFUID=AP04)" (pdf). *Applications Note 05*. Eppendorf (June 2005).

External links

- RCF Calculator and Nomograph (http://www.djblabcare.co.uk/djb/info/6/user_tools)
- Centrifugation Rotor Calculator (http://www.changbioscience.com/cell/rcf.html)
- Selection of historical centrifuges (http://vlp.mpiwg-berlin.mpg.de/technology/search?-max=10&-title=1&-op_varioid=numerical&varioid=3) in the Virtual Laboratory of the Max Planck Institute for the History of Science